

REMARKS

Applicants have carefully considered this Application in connection with the Examiner's Action, and respectfully request reconsideration of this Application in view of the above Amendment and the following remarks.

Applicants have cancelled non-elected Claims 11 – 24, 30, and 35 – 46. Applicants have added new Claims 47 – 48.

Pending in this application are Claims 1 – 10, 25 – 29, 31 – 34, and 47 – 48.

I. Claims 1 – 10

A. 35 U.S.C. §103(a); U.S. Patent No. 5,637,533 to Choi in view of U.S. Patent No. 5,618,746 to Hwang et al.

Claims 1, 4, 6, 8, and 10 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,637,533 to Choi (“Choi”) in view of U.S. Patent No. 5,618,746 to Hwang et al. (“Hwang”). The Examiner asserts that Choi discloses the use of RuO₂ as a diffusion stuffer but does not teach depositing a layer of Ru on the inter-level dielectric substrate and a layer of RuO₂ on the Ru layer. The Examiner asserts that it would have been obvious in view of Hwang to use the layer of Ru as a diffusion-blocking film that has a high conductivity and prevents silicon diffusion. See Office Action, Page 3.

Applicant respectfully asserts that the claims are not obvious in view of Choi in combination with Hwang. Choi pertains to a method for fabricating a diffusion barrier metal layer to prevent a silicide from being formed between the barrier metal and silicon. See Choi, Col. 1, lines 35 – 40. Thus, **Choi pertains to a barrier that serves to prevent silicon diffusion.** By contrast, **the current claims pertain to a method for preventing copper diffusion** during the fabrication of integrated circuits. See, Claim 1, Title, and Page 7, lines 9 – 11. Similarly, Hwang pertains to the use of an iridium or ruthenium film to prevent silicon diffusion. See Hwang, Col. 3, lines 26 – 28. Claim 1 pertains to a method in which the barrier layers never contact silicon. As the plain language of Claim 1 states, the Ru and RuO₂ layers lie directly between the inter-level dielectric substrate (“ILD”) and the copper layer. Thus, the current claims allow for the fabrication of integrated circuits

in which the copper electrofill is separated from the ILD by only the barrier layer, which eliminates the need for an additional Cu seed layer. See, Specification, Page 6, lines 10 – 13. Neither Choi, nor Hwang, nor the references in combination, teach or suggest the fabrication of integrated circuits using barrier layers in this manner to prevent copper diffusion.

For these reasons, Claim 1 and its dependent Claims 4, 6, 8, and 10 are patentable over Choi in view of Hwang.

B. 35 U.S.C. §103(a); Choi in view of Hwang and the Examiner’s Remarks

Claim 2 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Choi in view of Hwang and the Examiner’s remark. In particular, the Examiner asserts that Choi in view of Hwang teaches the formation of multiple layers of Ru and RuO₂ because mere duplication of working parts of a device involves only routine skill in the art. First, Applicant respectfully asserts that the current claims do not pertain to a device but rather to a method for preventing copper diffusion during the fabrication of integrated circuits. As discussed above, Claim 1 is patentable over Choi in view of Hwang because these references in combination do not teach the fabrication of a barrier layer that prevents copper diffusion. For that reason, Claim 2, which is dependent on Claim 1, is patentable over Choi in view of Hwang, taking into consideration the Examiner’s remark.

Claims 3, 5, 7, and 9 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Choi in view of Hwang and the Examiner’s remark. In particular, the Examiner asserts that depositing the RuO₂ layer by an atomic layer technique and by an electrochemical technique are art-recognized equivalents. First, Applicants respectfully assert that the Examiner’s reliance on the “art-recognized equivalents” reasoning is misplaced because this reasoning applies only to equivalent compositions and components within a device claim. See MPEP §2144.06. The current claims are method claims. Applicant also respectfully asserts that the current claims pertain to a method for preventing copper diffusion during the fabrication of integrated circuits. Choi in view of Hwang is directed to the prevention of silicon diffusion and does not teach or suggest a method to prevent copper diffusion. For that reason, Claims 3, 5, 7, and 9, which are dependent on Claim 1, are patentable over Choi in view of Hwang, taking into consideration the Examiner’s remark.

II. Claims 25 – 29

A. 35 U.S.C. §102(b); Choi

Claims 25 and 28 – 29 stand rejected under 35 U.S.C. §102(b) as being anticipated by Choi. The Examiner asserts that Choi teaches a method for controlling copper diffusion during the fabrication of integrated circuits that involves depositing one or a plurality of layers of RuO₂ on the ILD. Applicants respectfully disagree. Choi does not disclose the deposition of layers of RuO₂ on the ILD. Rather, Choi discloses the deposition of ruthenium on the substrate, followed by the implantation of oxygen into the ruthenium layer to form the “ultimate ruthenium oxide layer.” See Choi, Col. 2, lines 24 – 29 and 34 – 40. This process disclosed in Choi is different from the deposition of one or a plurality of RuO₂ layers directly on the ILD as contemplated by the current claims. For that reason, Claim 25, and its dependent Claims 28 – 29, are not anticipated by Choi.

B. 35 U.S.C. §103(a); Choi in view of the Examiner’s Remark

Claims 26 – 27 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Choi in view of the Examiner’s remark. The Examiner asserts that Choi discloses depositing an RuO₂ layer on the ILD using a thermal oxidation technique and a physical vapor technique. The Examiner also asserts that the deposition techniques are art-recognized equivalents and therefore the differences would have been obvious. First, Applicant respectfully asserts that the Examiner’s reliance on the “art-recognized equivalents” reasoning is misplaced because this reasoning applies only to equivalent compositions and components within a device claim. See MPEP §2144.06. The current claims are method claims. Furthermore, Applicant asserts that Choi does not teach or suggest the deposition of layers of RuO₂ onto the ILD because Choi teaches only the deposition of ruthenium followed by implantation of oxygen. For that reason, Claim 25, and its dependent Claims 26 – 27 are patentable over Choi in view of the Examiner’s remark.

III. Claims 31 – 32

Claims 31 – 32 stand rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,624,513 to Iwasaki et al. (“Iwasaki”). The Examiner asserts that Iwasaki discloses the prevention of copper diffusion during the fabrication of integrated circuits by using Ru as a diffusion barrier and eliminating a copper seed layer. Applicant respectfully asserts that Iwasaki does not

disclose the use of Ru alone as a diffusion barrier. Rather, Iwasaki utilizes a barrier metal composite that contains an “added element.” See Iwasaki, Col. 3, line 20. As stated in Iwasaki, to improve adhesion, an “added element” should be contained in the first conductive film whose main elements include ruthenium. See Iwasaki, Col. 3, lines 16 – 24. Thus, Iwasaki does not disclose the use of Ru as a diffusion barrier, but rather the use of a barrier metal composite including Ru and an added element. Iwasaki actually stresses that the added element is necessary to improve the adhesion between the films and that the use of Ru alone would be undesirable due to adhesion problems between the conductive film and the insulating film. See Iwasaki, Col. 3, lines 16 – 24, and Col. 1, lines 40 – 45. Thus, claims 31 – 32, which pertain to the use of Ru, rather than a composite metal layer, as a diffusion barrier, are not anticipated by Iwasaki.

IV. Claims 33 – 34

Claims 33 – 34 stand rejected under 35 U.S.C. §102(b) as being anticipated by Iwasaki. The Examiner asserts that Iwasaki discloses the use of Ru and RuO₂ as a diffusion barrier. Applicant respectfully asserts that Iwasaki discloses the use of a barrier metal composite to prevent diffusion and does not disclose the use of Ru and RuO₂ without an added element. Thus, claims 33 – 34, which pertain to the use of Ru and RuO₂, rather than a composite metal layer, as a diffusion barrier, are not anticipated by Iwasaki.

V. Conclusion

Applicants respectfully submit that, in light of the foregoing comments, Claims 1 – 10, 25 – 29, 31 – 34, and 47 – 48 are in condition for allowance. A Notice of Allowance is therefore requested.

If the Examiner has any other matters which pertain to this Application, the Examiner is encouraged to contact the undersigned to resolve these matters by Examiner's Amendment where possible.

Respectfully submitted,


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Nov. 4, 2005

Date